Unit 314
Variations on a theme of J.C. Maxwell
Integrated view of Deb 132, Unit 18, …

Maxwellean electrodynamics

$$(\kappa+\varepsilon\frac{\partial}{\partial t})E_x=\begin{vmatrix}\frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ H_y & H_z\end{vmatrix};\ -\mu\frac{\partial}{\partial t}H_x=\begin{vmatrix}\frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ E_y & E_z\end{vmatrix}$$

$$(\kappa+\varepsilon\frac{\partial}{\partial t})E_y=\begin{vmatrix}\frac{\partial}{\partial z} & \frac{\partial}{\partial x}\\ H_z & H_x\end{vmatrix};\ -\mu\frac{\partial}{\partial t}H_y=\begin{vmatrix}\frac{\partial}{\partial z} & \frac{\partial}{\partial x}\\ E_z & E_x\end{vmatrix}$$

$$(\kappa+\varepsilon\frac{\partial}{\partial t})E_z=\begin{vmatrix}\frac{\partial}{\partial x} & \frac{\partial}{\partial y}\\ H_x & H_y\end{vmatrix};\ -\mu\frac{\partial}{\partial t}H_z=\begin{vmatrix}\frac{\partial}{\partial x} & \frac{\partial}{\partial y}\\ E_x & E_y\end{vmatrix}$$

$$\varepsilon_0\mu_0=c^{-2}$$

with
$\vec{E} = \vec{e_x}E_x + \vec{e_y}E_y + \vec{e_z}E_z$ – electric field strength
$\vec{H} = \vec{e_x}H_x + \vec{e_y}H_y + \vec{e_z}H_z$ – magnetic field strength
ε – permittivity
ε_0 – permittivity of free space

μ – permeability
μ_0 – permeability of free space
κ – electrical conductivity
c – speed of light in vacuum

Variations 1

**1.1

$$(\kappa+\varepsilon\frac{\partial^2}{\partial t^2})E_x=\begin{vmatrix}\frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ H_y & H_z\end{vmatrix};\ -\mu\frac{\partial^2}{\partial t^2}H_x=\begin{vmatrix}\frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ E_y & E_z\end{vmatrix}$$

$$(\kappa+\varepsilon\frac{\partial^2}{\partial t^2})E_y=\begin{vmatrix}\frac{\partial}{\partial z} & \frac{\partial}{\partial x}\\ H_z & H_x\end{vmatrix};\ -\mu\frac{\partial^2}{\partial t^2}H_y=\begin{vmatrix}\frac{\partial}{\partial z} & \frac{\partial}{\partial x}\\ E_z & E_x\end{vmatrix}$$

$$(\kappa+\varepsilon\frac{\partial^2}{\partial t^2})E_z=\begin{vmatrix}\frac{\partial}{\partial x} & \frac{\partial}{\partial y}\\ H_x & H_y\end{vmatrix};\ -\mu\frac{\partial^2}{\partial t^2}H_z=\begin{vmatrix}\frac{\partial}{\partial x} & \frac{\partial}{\partial y}\\ E_x & E_y\end{vmatrix}$$

**1.2

$$(\kappa+\varepsilon\frac{\partial}{\partial t})E_x=\begin{vmatrix}\frac{\partial^2}{\partial y^2} & \frac{\partial^2}{\partial z^2}\\ H_y & H_z\end{vmatrix};\ -\mu\frac{\partial}{\partial t}H_x=\begin{vmatrix}\frac{\partial^2}{\partial y^2} & \frac{\partial^2}{\partial z^2}\\ E_y & E_z\end{vmatrix}$$

$$(\kappa+\varepsilon\frac{\partial}{\partial t})E_y=\begin{vmatrix}\frac{\partial^2}{\partial z^2} & \frac{\partial^2}{\partial x^2}\\ H_z & H_x\end{vmatrix};\ -\mu\frac{\partial}{\partial t}H_y=\begin{vmatrix}\frac{\partial^2}{\partial z^2} & \frac{\partial^2}{\partial x^2}\\ E_z & E_x\end{vmatrix}$$

$$(\kappa+\varepsilon\frac{\partial}{\partial t})E_z=\begin{vmatrix}\frac{\partial^2}{\partial x^2} & \frac{\partial^2}{\partial y^2}\\ H_x & H_y\end{vmatrix};\ -\mu\frac{\partial}{\partial t}H_z=\begin{vmatrix}\frac{\partial^2}{\partial x^2} & \frac{\partial^2}{\partial y^2}\\ E_x & E_y\end{vmatrix}$$

****1.3**

$$(\kappa+\varepsilon\frac{\partial^2}{\partial t^2})E_x=\begin{vmatrix}\frac{\partial^2}{\partial y^2} & \frac{\partial^2}{\partial z^2}\\ H_y & H_z\end{vmatrix};\ -\mu\frac{\partial^2}{\partial t^2}H_x=\begin{vmatrix}\frac{\partial^2}{\partial y^2} & \frac{\partial^2}{\partial z^2}\\ E_y & E_z\end{vmatrix}$$

$$(\kappa+\varepsilon\frac{\partial^2}{\partial t^2})E_y=\begin{vmatrix}\frac{\partial^2}{\partial z^2} & \frac{\partial^2}{\partial x^2}\\ H_z & H_x\end{vmatrix};\ -\mu\frac{\partial^2}{\partial t^2}H_y=\begin{vmatrix}\frac{\partial^2}{\partial z^2} & \frac{\partial^2}{\partial x^2}\\ E_z & E_x\end{vmatrix}$$

$$(\kappa+\varepsilon\frac{\partial^2}{\partial t^2})E_z=\begin{vmatrix}\frac{\partial^2}{\partial x^2} & \frac{\partial^2}{\partial y^2}\\ H_x & H_y\end{vmatrix};\ -\mu\frac{\partial^2}{\partial t^2}H_z=\begin{vmatrix}\frac{\partial^2}{\partial x^2} & \frac{\partial^2}{\partial y^2}\\ E_x & E_y\end{vmatrix}$$

**1.4 … your variations of Maxwellean equs, esp. regarding the associated engineering world.

Variations 2

**2.1 □-variation of the Maxwellean equations

$$\begin{vmatrix}\overrightarrow{e_x} & \overrightarrow{e_y} & \overrightarrow{e_z}\\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ H_x & H_y & H_z\end{vmatrix}=(\kappa+\varepsilon\frac{\partial}{\partial t})(\overrightarrow{e_x}E_x+\overrightarrow{e_y}E_y+\overrightarrow{e_z}E_z)$$

$$\begin{vmatrix} \overrightarrow{e_x} & \overrightarrow{e_y} & \overrightarrow{e_z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_x & E_y & E_z \end{vmatrix} = -\mu \frac{\partial}{\partial t}(\overrightarrow{e_x} H_x + \overrightarrow{e_y} H_y + \overrightarrow{e_z} H_z)$$

$\downarrow\downarrow$ □-variation

$$\frac{\partial}{\partial x} f(x,y,z) = \frac{\partial^1}{\partial x^1} f(x,y,z,t)$$

$$\rightarrow \qquad \frac{\partial^{\square}}{\partial x^{\square}} f(x,y,z) = f(x,y,z) - x\frac{\partial}{\partial x} f(x,y,z)$$

$$= (1 - x\frac{\partial}{\partial x}) f(x,y,z) \rightarrow$$

$$\begin{vmatrix} \overrightarrow{e_x} & \overrightarrow{e_y} & \overrightarrow{e_z} \\ \left(1 - x\frac{\partial}{\partial x}\right) & \left(1 - y\frac{\partial}{\partial y}\right) & (1 \mp z\frac{\partial}{\partial z}) \\ H_x & H_y & H_z \end{vmatrix} =$$

$$(\kappa + \varepsilon(1 - t\frac{\partial}{\partial t})(\overrightarrow{e_x} E_x + \overrightarrow{e_y} E_y + \overrightarrow{e_z} E_z)$$

$$\begin{vmatrix} \overrightarrow{e_x} & \overrightarrow{e_y} & \overrightarrow{e_z} \\ \left(1 - x\frac{\partial}{\partial x}\right) & \left(1 - y\frac{\partial}{\partial y}\right) & (1 - z\frac{\partial}{\partial z}) \\ E_x & E_y & E_z \end{vmatrix} =$$

$$-\mu(1 - t\frac{\partial}{\partial t})(\overrightarrow{e_x} H_x + \overrightarrow{e_y} H_y + \overrightarrow{e_z} H_z)$$

**2.2 Fractional derivative variation of the Maxwellean equations, f.e.

$$\frac{\partial}{\partial x} f(x,y,z,t) = \frac{\partial^1}{\partial x^1} f(x,y,z,t) \rightarrow \frac{\partial^{\frac{1}{2}}}{\partial x^{\frac{1}{2}}} f(x,y,z,t) = ? \rightarrow$$

???

Untersuchen Sie – in Analogie zur Exegese der Maxwellschen Gleichungen – , welche 3D-Verhaltensmuster die hier angegebenen Variationen generieren und diskutieren Sie mögliche technische Anwendungsfelder. → **Top-down Feldtheorie**.(„Wir werfen eine mathematische Angel aus – mal sehen, welcher Engineering-Fisch anbeisst“).

References

[1] https://en.wikipedia.org/wiki/Maxwell´s_equations
[2] https://en.wikipedia.org/wiki/Euclidean_vector
[3] Ref. in Deb 132
[4] https://en.wikipedia.org/wiki/Fractional_calculus
[5] M. Schmidt, H. Lipson. Distilling Free-Form Natural Laws from Experimental Data. Science Vol. 324, Issue 5923, pp. 81-85
[6] A. Grimmer. Ein ganzes Labor auf einem Chip. KlarText 2019, S.38-41 https://klartext-preis.de/meldungen/ein-ganzes-labor-auf-einem-chip/

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